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# THE VARIATIONS OF GLACIERS. XI[1]

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The following is a summary of the *Tenth Annual Report* of the International Committee on Glaciers.[2]

### REPORT ON GLACIERS FOR 1904

*Swiss Alps.*—Of the ninety glaciers under observation in Switzerland, seventy-three were measured in 1904. Five are uncertain, and the others are retreating or are stationary; none are surely advancing. We therefore see that there is a still greater tendency to retreat this year than last. The temperature in 1904 was markedly above the normal, and this undoubtedly had some influence on the retreat of the glaciers.[3]

*Eastern Alps.*—The tendency to retreat is nearly everywhere noted. Of fifty-one glaciers observed, forty-four are retreating and only four actually advancing. Here also we find an increased tendency of the glaciers to recede. In the Ortler group the Duldenferner has advanced 11 meters since last year, but the others have been retreating at the rate of from 3 to 10 meters a year. The Fürkeleferner has been retreating much faster, namely, 31.7 meters per year since 1899. In the Oetztal the retreat is also general at the rate of from 10 to 20 meters per year. The Mittelbergferner has retreated 119 meters since last year; the year before that its retreat was 83 meters. The Mitterkarferner has advanced 3.3 meters per year since 1901. The Vernagtferner is about stationary, but its rate of motion has diminished, and a retreat will probably be reported soon. The velocity of the Guslarferner has also diminished. On the other hand, the motion of the Hintereisferner has slightly increased, but the end has retreated 20.6 meters since last year. All the glaciers of the Stubaï group are retreating from

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[1] The earlier reports appeared in the *Journal of Geology*, Vols. III–XIII.

[2] *Archives des sciences physiques et naturelles* (Geneva, 1905), Vol. XX, pp. 62–74, 169–90.

[3] Report of Professor Forel and M. Muret.

3 to 10 meters per year. The Gliederferner, in the Zillertal, has advanced 34 meters since 1899 and has formed a moraine in front; its motion is a third less than it was from 1897 to 1899, during which time it advanced 36 meters; the very end is still swollen, but the rest of the glacier is thinner than normal. The other glaciers of this group are retreating or are stationary. The glaciers of the Venediger group are all retreating at rates varying from 0 to 22 meters per year. The Grosselendkees in the Ankogel group has advanced 1.4 meters since 1903. The other glaciers of this group and those of the Glockner are retreating.[1]

*Italian Alps.*—The snow-fields of the Cavallo, which were reported as having increased considerably in 1903, were found in 1904 to have diminished very much. The glaciers on the south side of Monte Rosa seem to be advancing, but they have not yet reached their limits of 1901. In the Graian Alps there is evidence of a considerable diminution of the glaciers. The glaciers on the south side of Mont Blanc are in general retreating, and in some cases markedly. The glacier des Jorasses, which has been retreating, shows evidence of an approaching advance. The general result regarding the Italian glaciers of Mont Blanc is that the phase of retreat is about finished, and that the thickening which began in the upper reservoirs is now approaching the ends and about to cause an advance. The snowfall in the higher regions has been very heavy.[2]

*French Alps.*—A careful study of the glacier Noir and the glacier Blanc has been made and maps prepared on the scale of 1/10,000.[3] These two glaciers, which are very near together have shown striking differences in their behavior. The glacier Noir has been retreating steadily since 1860; and the glacier Blanc, on the other hand, retreated from 1865 to 1886, but advanced between 1889 and 1896; since then it has been retreating. It occupies a very high reservoir, 3,000 to 3,300 meters in altitude, and has a very clean surface. The increased precipitation which occurred toward the end of the nineteenth century caused it to advance. The glacier Noir, on the other hand, lies, for its greater part, in a deep valley, and has been much affected by the warm weather, and has consequently retreated.

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[1] Report of Dr. H. Angerer.

[2] Report of Dr. F. Porro.

[3] Charles Jacob and George Flusin, "Étude sur le Glacier Noir et le Glacier Blanc," *Annuaire de la Société des Touristes du Dauphiné*, 1905.

Professor Kilian[1] has published a short account of the glaciers of the Dauphiné, in which he concludes that there is a general tendency toward the diminution of these glaciers, and he thinks that a number of them will disappear before long; some of the smaller ones have already disappeared.

All the glaciers of Savoy which have been observed are retreating, and some of the small ones have disappeared. The same statement applies to the glaciers of the Pyrenees, with the exception of one, the Pai Bache, which has increased since 1883, but seems now to be retreating.[2]

*Norway.*—In the Jotunheim region twenty glaciers were found to be retreating and four advancing. In the Jostedal four are retreating and two advancing; whereas in the Folgenfon the three glaciers observed were all advancing. There seems to have been considerable difference in the snowfall in the different regions, but it does not seem to correspond to the changes in the glaciers.[3]

*Sweden.*—The Mika glacier was found to have advanced from 7 to 10 meters between 1902 and 1904.

*Greenland.*—The glacier of Jakobshavn has undergone many changes in its water front; sometimes a portion of the front has advanced, and then again, as a result of the calving of the ice, it has been cut back; but, on the whole, since 1902 the central parts of the end retreated nearly 400 meters, and the sides about 210 meters. The glacier has also diminished in thickness about 16 meters near the side. Other small glaciers show a slight retreat.[4]

*Russia.*—A large number of glaciers have been visited in the Caucasus, and they all seem to be retreating; but some of them show a swelling in their middle courses, which may cause an advance before long. In the Pamir there are many small glaciers, some of which have been advancing in the last few years.[5]

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[1] *Les Glaciers du Dauphiné* (Grenoble, 1904).

[2] Report of M. W. Kilian.

[3] Report of M. P. A. Oyen.

[4] Report of M. K. J. V. Steenstrup.

[5] Report of Colonel J. de Schokalsky.

*South America.*—Dr. Benrath has collected some observations of the glaciers in the Coast Cordillera of Peru, which show that they have been retreating for the last twenty-five years; and the bare condition of the ground in front of the ice shows that this retreat has existed for a still longer period. The existence of extensive moraines at some distance from the glaciers indicate a former glacial period in this region (12° south latitude).

Captain Crosthwait states that most of the larger glaciers seen by him during a trip through the straits of the southern end of Patagonia showed signs of shrinkage.

*Africa.*—The crater of Kibo, Mount Kilimandjaro, was visited by Dr. Uhlig in 1901 and 1904. In the former year the crater contained more snow and ice than at the time of Dr. Meyer's visit in 1898, but the snow did not extend to as low a level on the slopes of the mountain; and this was after a very dry season. In 1904, on the contrary, after a season of unusually heavy precipitation, there was less snow and ice in the crater of Kibo than has been reported at any earlier period.

*Canada.*—A very interesting account of the glaciers of Canada has been given by Miss Ogilvie.[1] She divides them into three groups: First, those of the central and eastern Rockies which, in general, lie in very deep valleys surrounded by nearly vertical cliffs, and are fed by avalanches from the slopes, or from the hanging glaciers above; that is, they are débris glaciers. Their whole course is practically below the snow-line, and they are covered very completely with rubbish, so that for a large part of their surface the ice is entirely invisible. Of this group the Victoria glacier has retreated but little. The glacier of the Ten Peaks valley is advancing. The glacier of the Consolation valley was but slightly shorter than at the time of its recent maximum extension, and the other glaciers of this group are probably in the same general condition. The second group of glaciers, which lie in the western Rockies and Selkirks, are practically like the ordinary valley glaciers of Switzerland, except that they are, as a rule, broader and shorter The moraines are practically similar to the moraines of the Swiss glaciers. Of this group the Wapta shows a recent rapid retreat. The Illecillewaet, the Asulkan, the Geikie, and the Deville glaciers are all in rapid retreat. Of a third class of glaciers, intermediate between the other two, one is advancing and the other retreating.

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[1] The Effect of Super-glacial Débris on the Advance and Retreat of Some Canadian Glaciers," *Journal of Geology*, Vol. XII (1904), pp. 722–43.

Messrs. Vaux have continued their observations of some of the Canadian glaciers as follows:

There is evidence of a continued retreat of the Victoria glacier, at about the rate of previous years. The Illecillewaet continues to recede, the tongue being 5 feet behind the location of last year. This recession is much less than that noted for several years past. The glacier continues to decrease in thickness and width. The slight advance of the Asulkan glacier, noted the last three years, appears to have ceased, and in 1904 the tongue was 11 feet below the range line of 1899, showing a recession of 5 feet since 1903. Changes in the form of the glacier appear slight. The Yoho glacier is evidently retreating and decreasing in thickness. It was last visited in 1901; since that date the tongue has receded 89 feet, or on an average of 29⅔ feet per year. A very splendid ice-arch on the right side of the glacier was one of the notable features last summer.

## REPORT OF THE GLACIERS OF THE UNITED STATES FOR 1905.[1]

Professor U. S. Grant has visited the glaciers of Prince William Sound, Alaska, and reports various changes in them. The Shoup glacier lies in the neighborhood of Valdez; two large rocks are being exposed by the retreat of the glacier which were not visible four years ago; along the sides there is a broad space of bare ground free of soil and vegetation, and the whole aspect of the glacier indicates that it is retreating. Photographs were obtained from fixed points which will be useful in determining future changes. The western part of Columbia glacier—i. e., the part west of Heather Island—is rapidly discharging, and presents apparently the same appearance as when visited by the Harriman Expedition. At the north end of the small island north of Heather Island, on which the front of the glacier is resting, and where a few years ago the glacier had intruded and overturned the front of a forest, a photograph was obtained from the same position as one taken by Mr. Gilbert in 1899. At this point the front of the ice has retreated 160 feet since 1899. On the ground since vacated by the glacier, there is very little vegetation—practically nothing except fireweed, which has encroached upon this territory only a few feet. Brooks glacier enters the head of Unakwik Bay. It is formed by the junction of two branches, and comes down to tide water; the front is about a mile and a quarter in width and is actively discharging. As viewed from a distance of about a mile, trees and bushes are seen to come down to the ice, and there is no zone, or a very narrow one, between the ice and the vegetation. The extreme front of Barry glacier, Port Wells, has retreated at least a mile since 1899. The long point which projected into Doran Strait for nearly two miles has entirely disappeared, and the front is now nearly straight across. The little tongue of ice which lay along the east side of the glacier has also disappeared. Photographs and sketches of the front of the glacier were obtained to show its exact position in 1905.

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[1] A synopsis of this report will appear in the *Eleventh Annual Report* of the International Committee. A report of the glaciers of the United States for 1904 was given in this *Journal*, Vol. XIII, pp. 316–18.

Photographs and observations were made of a number of the smaller glaciers and all seem to be in retreat. Several of these have been observed for the first time, and the data obtained will serve as a basis for future changes.

A short account of the glaciers of the Wrangell Mountians, with a map showing their locations, is contained in Mr. W. E. Mendenhall's "Geology of the Central Copper River Region," Alaska.[1] Some of the glaciers are 30 and 40 miles long. Those of the west slope are smaller than those flowing in other directions, which is ascribed to the volcanic heat of the rocks. The glaciers were at one time much larger than they are now, but no information is given regarding recent changes.

The Yakutat Bay glaciers were especially studied last summer by Professor Tarr and Mr. Martin,[2] and the positions of the glaciers compared with their positions as noted by Professor Russell in 1891, and by the Harriman expedition in 1899. The Turner glacier, which reaches the sea in Disenchantment Bay, indicated a general recession between 1891 and 1899, and a slight advance on the sides between 1895 and 1905 with a recession in the center. The northwestern half of Hubbard glacier has also advanced in the last six

[1] U. S. Geological Survey, *Professional Paper No. 41.*

[2] "Glaciers and Glaciation of Yakutat Bay," *Bulletin of the American Geological Society,* Vol. XXXVIII, pp. 145–67.

years, though the amount could not be determined; there is no definite evidence of advance in the southern side of the glacier. One of the Indians who accompanied the expedition was confident that the Hubbard had been advancing for the last ten or twelve years, but this idea does not seem to be well supported by the maps. The Nunatak glacier ends in tide-water with a short arm resting on the land, separated from the main stream by a rocky knoll, which was completely surrounded by the ice when visited by Professor Russell in 1891. Comparison of Mr. Gilbert's photograph of 1889 with one taken in 1905 shows that the tide-water front has retreated almost a mile. The arm resting on the land has also shortened from 200 to 400 yards, so that the knoll is now not more than half surrounded by the ice. The Hidden glacier ends some distance from tide-water on a gravel deposit which in places is underlain with ice. The photographs show that this glacier has retreated about one-quarter of a mile. The Cascading glacier near the Nunatak is retreating, as are also many other small glaciers which were examined by Messrs. Tarr and Martin. One remarkable glacier on the west side of Disenchantment Bay, whose end is about 1,000 feet above the water, slid out of its bed and was precipitated into the bay on July 4, the day after it had been photographed. The glacial gravels in this region were especially studied, and the late glacial history there corresponds very closely with that made out for Glacier Bay. The great earthquake of September, 1889, which appears to have been central in the neighborhood of Yakutat Bay, and which made a number of faults in that region, has not left any marked changes in the glaciers such as have been observed in Glacier Bay. It is possible that the breaks caused by the earthquake have been made up since.

Not very much information has been received regarding Muir glacier, but no changes have apparently taken place. The same report is made regarding the Taku glacier, which apparently is not undergoing any special changes; but photographs taken in 1905 reveal a marked advance over the position of the glacier in 1890, as shown by a sketch made that year. Davidson glacier is apparently retreating, but no measures have been made (Davidson). A noticeable recession has taken place in the hanging glaciers in the Chilcat

River Valley between 1898 and 1905, although no measures have been made. The summer of 1905 was unusually warm, and the glacier streams were very much larger than usual (Flemer).

Last summer the Mazama Club of Portland, Oregon made its annual excursion to Mount Rainier. General Howard Stevens, who, with Mr. P. V. Van Trump, made the first ascent of Mount Rainier in 1870, was one of the party. He recognized some marked changes since his former visit. The Paradise glacier has retreated about 800 feet. The snow in the western crater on the summit was at least 40 feet lower than in 1870, and the wind-swept ridge separating the two craters, which was bare in 1870, was covered by a mound of snow 30 feet high in 1905. Mr. Longmire, who has been living near Mount Rainier for the last twenty-five years, thinks the Nisqually glacier has retreated a quarter of a mile in that period (*Mazama Magazine*). Professor J. N. LeConte made some measures of the movement of this glacier, and found a velocity of 22.4 inches per day at a distance of 3,000 feet from the end. He also erected a monument near the end as a station for the determination of future changes.[1] The precipitation in Oregon has been below normal for some years. The record at Portland shows a mean annual precipitation of 46.83 inches; whereas the average for the last six years has only been 35.47 inches. It is not surprising, therefore, that the glaciers observed on the southern side of Mount Hood are retreating; the White glacier is retreating less rapidly than the Zig Zag and the small one to the west (Montgomery). There is no new information regarding the recent variations of the Mount Adams glaciers, but a comparison of photographs taken in 1895 and 1901 shows that the ice at the end of Avalanche glacier, on the west side of the mountain, diminished in thickness at least 25 feet in that interval.

The Sperry and Harrison glaciers, and a small unnamed one on Mount Jackson, Montana, give evidence of a very recent retreat by the terminal moraines which they have deposited a short distance from their present ends, and which are so recent that vegetation has not yet taken hold upon them. (Chaney.)

Judge Henderson measured the movement of the Arapahoe glacier, Colorado, and found a velocity of 27.7 feet from August 30, 1904, to the same day one year later. The glacier continues to shrink along the sides, but has not retreated in the center. The snow-line, which was quite low in 1903 and 1904, has receded nearly to the bergschrund, a change which is not explained by the records in the nearest Weather Bureau stations.[1]

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[1] His complete article will be published in the new *Zeitschrift für Gletcherkunde* and in the Sierra Club *Bulletin*.

Hallet glacier seems to be a trifle larger than it was a year ago. The snow seems more abundant, showing a curious difference from the Arapahoe glacier near by. (Mills.)

[1] "Arapahoe Glacier in 1905," *Journal of Geology*, Vol. XIII (1905), p. 156.